

## SECTION 2 - NESTING BEACH SURVEY ACTIVITIES

### STATEWIDE NESTING BEACH SURVEYS

South Carolina's statewide marine turtle nesting beach surveys (SNBS) are performed by a network of people who receive training and guidance from the SCDNR's Marine Turtle Conservation Program. Surveyors may work principally within conservation organizations, state or local governments, universities, state parks, federal agencies, and private consulting groups. One product of SNBS is a minimum total count of nests on project beaches for each species. The broad coverage provides data for management decisions such as the timing of coastal construction activities. A limitation of the SNBS program is that effort varies among years and among beaches as survey areas are added or lost.

If your permit authorizes you to **conduct nesting surveys** you are authorized to conduct the following activities:

- **identify and mark nests**
- **inventory nests at day 75**
- **recover hatchlings**

Unless specifically stated on the permit personnel are NOT authorized to conduct the following activities:

- **inventory nests three days after emergence**
- **use probes (other than fingers) to locate clutches**
- **relocate nests**
- **screen nests with self-releasing screens/cages**
- **screen nests with restraining cages**
- **use a self releasing hatchery**
- **use a restraining hatchery**
- **conduct nighttime surveys**
- **conduct public turtle watches**
- **conduct public hatchling releases**

Nesting beach surveys involve a daily survey during the entire laying season (May – August) of a specific beach area (as specified on the permit) to identify, enumerate, and evaluate nesting activities. During nesting surveys, surveyors count and identify "crawls," which are the marks created in the sand by marine turtles that have attempted to nest. The official marine turtle nesting season is between May 1, when loggerheads begin nesting, and October 31, after which most nests have hatched. Because of potential disturbances to nesting females and the difficulty of locating and interpreting crawls in the dark, nesting surveys may not be conducted at night. For best viewing of crawls, nesting surveys should begin shortly after sunrise but never earlier than ½ hour before sunrise. At night, marine turtles coming ashore to nest may be scared away by vehicles used to survey at night, and hatchlings are vulnerable to being run over. Both adult and hatchling marine turtles can be disoriented by the artificial light produced by headlights. Ruts made by vehicles can trap and disorient turtle hatchlings.

Surveyors should traverse the beach along the most recent high tide line. Surveying in this location is important to ensure that turtle crawls are not obscured before they can be evaluated but also to avoid any unintended disturbance to nesting shorebirds (see section on beach-nesting birds).

Upon discovery of a crawl, surveyors should make a visual determination as to whether the crawl was a nesting emergence (i.e., a nest) or non-nesting emergence (often called a “false crawl”); they also determine what species of turtle made the crawl. After each crawl is evaluated and documented, the tracks should be marked to avoid duplicate reporting. To accomplish this, a surveyor may obliterate a section of the upper track (not the nest site) by sweeping his/her feet across the track or by crossing over the track (well above the high tide mark but not over the clutch) with a survey vehicle.

Nesting surveys may only be conducted within the boundaries specified on the permit. Ideally, boundaries should not change, either within a season or from year to year. Requests for expansion of authorized nesting survey areas must be submitted in advance and in writing to SCDNR. It is imperative that survey areas do not overlap. Please inform SCDNR immediately of any reduction in survey efforts so that steps can be taken to ensure continuity in nesting beach coverage. It is extremely important that SCDNR be informed of any changes in monitoring effort in order to maintain accurate and consistent nesting survey records. Survey boundaries should be permanent and specific. GPS coordinates are highly desirable, in addition to physical landmarks such as inlets, state roads, county lines, etc. Street addresses are preferable to condominium names, which may change at any time.

An excellent reference for illustrations of instructions in these guidelines entitled *Nesting Survey Field Guide* can be found on the volunteer resources page at <http://www.dnr.sc.gov/seaturtle/volres.htm>. It is recommended that you refer to this document often.

### **WATCH OUT FOR BEACH-NESTING BIRDS**

Operating vehicles, including ATVs, on the beach can destroy wildlife habitat and be harmful or fatal to wildlife. This is one reason that beach-driving is strictly prohibited year-round to all unauthorized personnel. The eggs and flightless young of beach-nesting birds can be virtually invisible, especially from a vehicle. Beach-nesting birds lay their eggs in shallow scrapes directly on the sand above the high tide line. Least terns and black skimmers nest in colonies and are often very vocal when approaching their nests. American oystercatchers and Wilson’s plovers nest singularly and their nests may be more difficult to see because adults leave eggs and chicks long before a vehicle approaches the nest. Young chicks wander between the water’s edge and dunes to feed and may hide and rest in tire ruts. Beach-nesting birds may be active from mid-March through the end of August. Therefore it is best to avoid beach-driving whenever feasible. Surveyors should become familiar with and keep alert for shorebird chicks in the intertidal zone as well, since these birds use this habitat once they leave their nests. Everyone authorized to operate a vehicle on the beach during these periods of the year should take the following precautions:

- Enter the beach only at designated access points and proceed directly to the hard-packed sand near or below the high tide line. If beach conditions require driving above the high tide line, avoid those areas with known marine turtle nests or shorebird breeding areas.
- Avoid driving on the upper beach whenever possible, and never drive over any dunes or over beach vegetation.
- Avoid the wrack line or areas of dense seaweed, which may contain marine turtle hatchlings or baby birds.
- Minimize ruts on the dry sandy beach by lowering tire pressure and using 4WD, particularly in front of marine turtle or bird nests.
- Drive slowly. Movement should be slow enough to observe any bird eggs, chicks, or marine turtle hatchlings in the vehicle's line of travel. Please be aware that recently hatched chicks often feed along the water's edge. They may freeze in place rather than run away when ATVs or other vehicles approach.
- Whenever possible, avoid driving on the beach at night. If you must drive on the beach at night, turn headlights off when parking. If you observe a marine turtle crawling out of the surf, stop the vehicle and turn off all lights. No additional movement should occur until the turtle moves across the beach and begins digging her nest or moves into deeper water.

For additional information on how to identify and protect shorebirds, contact SCDNR's Coastal Bird Biologist, Felicia Sanders at (843) 520-0961. You can also contact the USFWS (USFWS, Migratory Birds and State Programs, 1875 Century Boulevard, Suite 240, Atlanta, GA 30345-3301).

### **SPECIES IDENTIFICATION AND DETERMINATION OF NEST SUCCESS**

The tracks can be used to identify the species of turtle and whether or not it nested. The following outline describes how to use crawl evidence to make these identifications.

#### **I. Identify which is the incoming (emerging) track and which is the outgoing (returning) track?**

- As a turtle crawls it pushes sand backward with each flipper stroke
- If one track is shorter, it will be the incoming track
- If tracks overlap, the outgoing track will be on top
- "V" shape impression in the sand made by the flipper claws always points to where the turtle came from. It is easier to see in the intertidal zone

#### **II. What species made the crawl (loggerhead, green turtle or leatherback)?**

For illustrations of crawls made by different species, please refer to the *Nesting Survey Field Guide* on the volunteer resources page.

**III. Is the crawl a nest or a non-nesting emergence?** It is important to record both types of emergences.

**A.** Identify emerging and returning tracks by their direction (see I. above)

- B. Follow the path taken by the turtle and look for the following nesting attributes
  - a. Incoming tracks disappearing under covered area
  - b. Body pit (always investigate the last body pit made) – a turtle first creates a body pit by pushing the top layer of soft, dry sand out of the way so she can dig into firm sand. The body pit usually covers up the crawl.
  - c. Thrown, wet, dark sand
  - d. Uprooted vegetation
  - e. Crescent arc
  - f. Differential crawl lengths if the turtle laid her nest during an outgoing tide
- C. Evidence of an abandoned nesting attempt. If present, the crawl can be considered a non-nesting emergence (i.e., false crawl).
  - a. Very little or no sand disturbed other than tracks
  - b. Considerable amount of sand disturbed from a digging effort, but with the crawl exiting the disturbed area and continuing toward the dune before turning toward the ocean
  - c. Considerable amount of sand disturbed from a digging effort, but with a smooth-walled or abandoned/open egg chamber (15-25 cm diameter) in the center of a pit within the disturbed area
  - d. No differential in crawl lengths on evenings when the tide is rising

#### **MARKING THE LOCATION OF THE NEST**

Marking is necessary for monitoring the nest during incubation, protecting the nest from hazardous activities being conducted on the beach and collecting data on reproductive success. To locate the clutch in a fresh nest, note the characteristics of the nest site to predict the location of the clutch. To approximate the location of a loggerhead clutch, follow the tracks emerging from the water and leading towards the nest site. Commonly, the clutch is located about two feet into the broad disturbed area (the nest mound) from this approach; it is generally centered between the edges. To estimate the location of a green turtle clutch, measure about three feet back from the escarpment created by the final covering activities. On leatherback nests, measure about four and one half feet from the escarpment created by the final covering activities.

The precise location of the clutch at a fresh nest site should be determined by carefully digging shallow, finger probing holes into the nest feeling for the softer sand over the clutch. Alternatively, a tapered, T-handled dowel may be used to gently probe. Do not use shovels or any other tools. Probing a nest by a project participant is allowed only if they have been trained by SCDNR personnel or another highly experienced participant and the participant possesses a current SCDNR Letter of Authorization under his or her principal permit holder. Focus the digging effort at the center of the mound of sand that was piled by the nesting turtle. Once the soft sand is found, and the eggs beneath are verified, fill the hole with moist sand and gently pat the sand surface above the eggs with your hand. Replace the dry sand over this area to the depth present before you began, and place a temporary marker over the clutch site. Rebury any other holes dug in the nest site so that the nest site is restored to its original condition.

To mark the nest site, measure the exact distance from the confirmed clutch location to one or more marking stakes on the dune. Stakes should be labeled with an identifying nest number. Additionally, a nest sign can be attached to one of the stakes (signs are available from SCDNR). On beaches where removal of marking stakes by the public is an ongoing problem, an additional stake, driven deeply and hidden from view, should be placed a measured distance landward of the first two. As added insurance, an aluminum marker can be buried hand-deep and 24 inches from the approximate clutch location in a standardized direction. This metal marker can be found later with a metal detector. This is also useful in the event that tidal inundation washes away all primary stakes. There should always be a back-up system of marking in case all primary markers are lost. Please keep in mind when driving stakes that at least some undiscovered and/or unmarked clutches are probably present on every beach. Drive stakes with caution.

### NEST RELOCATION

Nest relocation must be considered a management technique of last resort and only if the likelihood of the nest surviving to hatch is nil. Disposable gloves should be worn at all times when relocating nests. Moving marine turtle eggs may create adverse impacts. Movement alone is known to kill developing embryos by rupturing delicate membranes that attach to the top of the egg. We also know that the incubation environment greatly influences the developing embryo and that nest relocation can involve the transfer of eggs from an appropriate environment to an inappropriate one.

**The only reason to relocate a nest is when it is laid seaward of the debris line marking the spring high tide.** If foot traffic is heavy, a nest can be roped off so that pedestrians avoid it. If a nest is laid near a light that may disorient the hatchlings, the light should be kept off or shielded. Lighting problems are not a valid reason to relocate nests. Use the following decision-making protocol when evaluating relocation:

Question 1: Will the nest be destroyed in situ?

If NO: No action required. Leave nest where it was deposited.

If YES: Go to question 2

Question 2: Can the nest be moved directly inland to a stable dune?

If YES: Move to new location directly inland.

If NO: Move to next best available site closest to original nest location.

If a nest requires relocation, it should be moved as early in the morning following its deposition as possible. After deposition, the potential for movement-induced mortality in marine turtle eggs increases rapidly. Eggs should be moved before 9 AM (turtles may nest as early as 9 PM the preceding night). Once the eggs are located, carefully remove the sand from around the top eggs. Note total number of eggs laid and number of broken eggs. Individual eggs should be gently lifted from the egg chamber and placed into a rigid container with a 2 – 3 inch layer of moist sand on the bottom. Sand should not be placed between layers of eggs. When moving

eggs, be sure to maintain each egg's original orientation; do not rotate eggs in any direction and avoid any abrupt movements. As eggs are placed in the container, be sure that they do not roll. When all eggs are in the container, place a hand towel over them and then stabilize the eggs by placing two inches of moist sand over them.

Find suitable beach habitat nearby that is successfully used by nesting turtles. Avoid relocating nests near inlets, as hatchlings will be swept into the marsh by incoming tides. Be sure that the new nest site is above the spring high tide level and is not in dense vegetation. Prior to removing eggs from the original chamber, dig a new egg chamber to the approximately the same depth, size and shape of the original egg chamber. The shape should resemble an inverted light bulb. The cockleshell is a good instrument to round out the bottom of the nest if you use posthole diggers. The depth of a loggerhead nest chamber should be 18-22 inches and the diameter of the spherical bottom should be approximately the size of a volley ball. After transferring all eggs to a bucket, make note of the depth and width of the original egg chamber and make final adjustments to the new egg chamber. Dry sand should not be allowed to fall into the egg chamber. To prevent this, move the top dry layer of sand away from the entrance of the nest chamber. After all the eggs have been transferred into the new egg chamber, cover them with the moist sand collected from the original nest chamber and gently pat the sand surface above the eggs with your hand. Fill the remaining hole with dry sand. The relocated nest can then be marked and later evaluated for nest success. Nests in danger of being completely eroded away by high tides can be moved to safer areas anytime during incubation, with prior permission. Do not clear dune vegetation or restructure the dune profile.

## **PREDATOR CONTROL**

Many native and introduced animals are known to prey on incubating marine turtle eggs and hatchlings. Common predators in South Carolina include raccoons, coyotes, foxes, ghost crabs, feral hogs, and birds. Depredation is a part of the natural system and, to a certain extent, compensated for by the high reproductive output of marine turtles. However, predators will sometimes become so proficient at finding and destroying nests that they may threaten all the nests on a beach. Resource managers may sometimes control predators such as raccoons by trapping and removing nuisance animals from the beach. Animals cannot be relocated but must be destroyed. Trapping animals can be controversial with the public and may not be an option for many permit holders. Oftentimes, animal depredation increases where trash has accumulated on the beach. To avoid attracting increased numbers of predators to the beach where nests are incubating, trash should be removed. All predator removal programs to protect marine turtle nests should be approved by the SCDNR marine turtle conservation program.

## **Protecting Nests from Mammalian Predators**

Although raccoons are the most common predators of marine turtle nests in South Carolina, coyotes, foxes, and feral hogs may also be destructive to nests in some regions. They generally target nests either within the first few days after egg deposition or as hatchlings leave their shell (hatching odors and sounds from activity in nest can attract predators). When depredation becomes a serious problem (as an approximate guide, when greater than 10% of

nests are partially or completely depredated), measures should be taken to protect nests. Do not use screens unless you have a documented mammalian predator problem. The easiest method for controlling mammalian predation without killing the predators is to place a self-releasing screen or cage over threatened nests. Screens and cages must be centered exactly over the egg chamber to make it less likely that mammalian predators will burrow to the eggs from the side of the screen and to make sure that anchoring stakes placed along the edge of the screen will not enter the egg chamber. Because screens and cages may become partially or completely dislodged or covered with sand, they should be checked regularly. Self-releasing screens and cages should be checked each morning during the period of anticipated hatching, just in case some hatchlings have become trapped. Use of hatcheries must be approved by SCDNR.

Predators learn to overcome obstacles. Therefore, management techniques to keep them away from eggs should be incremental, staying one step ahead of the animals. Please consult SCDNR to discuss the best solution for your project.

### **Plastic versus metal material**

Both types of screening materials should be treated as potential litter since they are persistent and remain in the marine environment for a long period of time. It is extremely important to maintain screening material that is either protecting a nest or being stored on the beach during the season. It is also important to remove any remaining screening material from the beach at the end of each season, and especially before a major storm (see Section 8 of guidelines on storm response). Plastic is the preferred material (as long as it successfully protects the nest from predators) because of the unknown affect of metal on the magnetic field over the nest. Marine turtles use the earth's magnetic field to navigate in the marine environment. When metal screening is used the magnetic field over a nest is changed, which may alter the hatchlings' ability to navigate once they reach the ocean.

### **Screens (self-releasing)**

The screens used for this purpose are typically 4 X 4 foot pieces of either 2 inch mesh plastic or 2 X 4 inch mesh welded wire (do not use metal screen with a smaller mesh size as it is likely to trap emerging hatchlings). This type of screen is large enough to keep mammalian predators out, yet it allows hatchlings to escape from the nest without assistance.

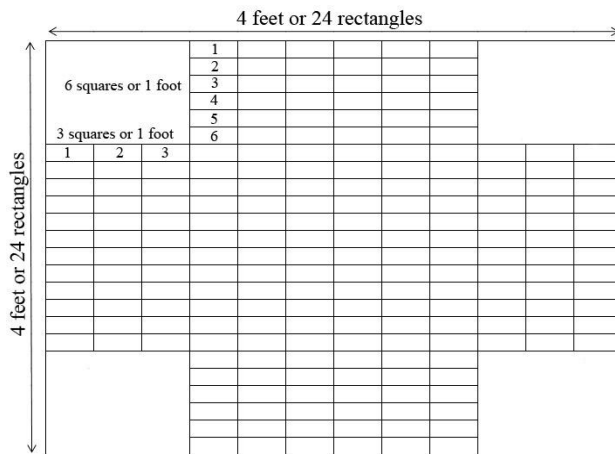
Once the egg chamber is re-covered with moist, then dry sand to the original level, mark the center of the egg chamber by drawing an X in the sand. Be sure that this marker is not inserted into the egg chamber. Level the surface of the sand in a 4 X 4 foot square centered on your temporary marker so that the screen will lay flat. Using stakes, secure the four corners of the screen. You may use tent stakes or make your own stakes of wood, PVC or some other durable material. If predators in your area are very persistent and dislodge screens with only four stakes, try using eight stakes and place the four additional stakes midway between the corners. If stakes are easily dislodged, longer or thicker stakes may be needed. In some situations, if screened nests are not marked with an appropriate sign, a beach user is likely to discover the screen and think that it should not be on the beach and pull it up. Marking screened nests may also be

necessary to prevent people from inadvertently injuring themselves on the screen or on any stakes. Because stakes and/or screens may become partially or completely dislodged, they should be checked regularly.

### Cages (self-releasing)

A cage is advantageous over a flat screen when predators are strong enough to pull up a staked screen, reach the eggs through the top of the screen or dig under it (e.g., raccoons, foxes, etc.). Self-releasing cages shall provide enough room for all hatchlings to completely emerge from the sand and shall have, on the ocean side of the cage, an area from which hatchlings can readily escape. The cages should be constructed of 2 X 4 inch mesh welded wire (do not use metal screen with a smaller mesh size as it is likely to trap emerging hatchlings). The cage should be oriented so that the horizontal 4-inch opening is parallel to the water's edge, and the vertical 2-inch high opening should not be obstructed by sand.

Most cages are anchored by burying one half of each side under the sand's surface. Enough of the cage should be above the sand surface to deter raccoons from reaching eggs through the mesh. Center the cage over the nest cavity and trace the edges of the cage in the sand. Remove the cage and carefully dig a trench six inches deep along the tracing of the edges of the cage. Place the cage into the trench and fill the trench with sand. When completed, the sand around the cage and over the nest cavity should be at the original level. If stakes are used to secure a cage, make sure they will not enter the egg chamber.



One piece of 4 x 4 foot (2 x 4 inch mesh) welded wire. Cut off 24 square (or 4 feet) length of wire. Cut out four corners as shown above. Fold down and use hog clips to hold together. Design courtesy of Sarah Dawsey, USFWS.



### Protecting Nests from Fire Ants

Marine turtle nests may be invaded by fire ants during incubation, hatching, or emergence. Both imported and native fire ants of the genus *Solenopsis* have been identified as predators of marine turtle nests. Fire ant researchers believe that fire ants may be attracted to the initial mucous that covers the eggs. Once they cue into this food source they establish foraging tunnels and regularly “check” on the eggs. Sometimes fire ants will forage up to 165 feet from their mound. When the turtles begin to pip out of their shells, the foraging ants bring the news



back to the mound and then are followed back by reinforcements. This may take a while depending on how far the mound is from the nest site. Researchers also believe that fire ants can forage beneath the surface so you may not always be able to tell if a nest has been invaded. It is important not to over-react to a potential or ongoing problem with ants. Some steps taken to protect nests from fire ants may be unnecessary and may do more harm than good.

It is important to be sure that any ants that are treated with the control agents are those that actually threaten the nest. There are many native ant species that may look like the harmful fire ants but do not cause problems for turtle nests. The presence of these ants may help to exclude the harmful fire ants. The easiest and safest way to help protect a nest from ants is to keep the nest site free of trash. The more trash at or near a nest site, the more likely ants are to find the nest.

If you have a severe fire ant problem and feel you need to treat proactively, please call us before treating. Please remember that you are baiting ants towards your nest. Be sure you have a significant problem before applying baits. If a clutch is deposited near an active fire ant mound or if fire ants begin to forage near a nest, then fire ant baits such as Amdro™, Esteem™ (Pyrproxifen), or Extinguish™ (Methoprene) may be used to control the ants. Extinguish™ (Methoprene) is recommended. For nests currently being attacked (fire ants in the nest), the fastest-acting product is Advion™. Data shows foraging activity stops within hours of treatment and kills ants within 48 to 72 hours. Follow all application instructions directly because it's the law. Product should be kept at least three (3) feet away from the egg chamber. Do not put these baits directly over a clutch. This will help keep emerging hatchlings from coming in contact with the baits. Apply them landward of the marked nest site, keep their use minimal (3 x 3 foot area; 9 ft<sup>2</sup>), broadcast spreading at no greater a rate than 1 to 2 lbs. per acre using a hand seeder spreader and follow label directions carefully. The best time to apply these products is late in the evening because the products break down in sunlight and water, and fire ants feed mainly at night in our hot environment. Baits need to be applied when there is little or no chance of rain within a 12 hour period. Please remember that you are baiting ants towards your nest. Be sure you have a significant problem before applying baits.

If many fire ants are seen entering a nest that may be hatching or emerging, the nest may be inventoried. Do not use a tool to dig. Wear rubber gloves to protect hands and arms during excavation. Follow the instructions in the guidelines for nest inventories regarding the handling of pipped eggs with live hatchlings and/or pre-emergent hatchlings. An early nest inventory should be done only because of a severe, well-documented problem. By excavating a nest early, the hatching and emergence process is disrupted which may adversely affect their ability to survive. Actions taken to control fire ants, including nest relocation and an early inventory are to be recorded in field notes, entered into the online nest database and included in the annual report.

### **Protecting Nests from Ghost Crabs**

Ghost crabs are a common, valuable part of the beach ecosystem and should not be targeted for removal unless they are entering a specific nest. Individual crabs can be trapped using

homemade ghost crab traps. The simplest trap is to bury a 3 inch diameter PVC pipe, one foot in length that is capped on one end. The pipe should be placed six inches from the active ghost crab burrow that is near the marine turtle nest. Ghost crab traps should not be placed in or above the nest at anytime. Nests should not be disturbed to capture a ghost crab. Be sure the pipe is not near the nest to avoid any damage to eggs when buried. Bury the pipe vertically until the open end of the pipe is flush with the sand surface. Do not bait ghost crab traps. Baiting a ghost crab trap will attract other predators (e.g., raccoons, fire ants, canines, etc.) to your nest. These other predators will create far more problems than ghost crabs. Remove all ghost crab traps after 45 days of incubation because hatchlings can fall into them.

## ISSUES DURING INCUBATION

### Nest Depredation

During incubation, it is possible for a nest to be depredated by a number of predators. If a nest is partially depredated by mammalian predators, the remaining intact eggs need to be relocated to a new nest chamber. Excess egg contents (e.g., yolk, albumin) should be carefully wiped off of remaining intact eggs using a small amount of sand. Remaining eggs are wiped off and relocated to avoid (1) subsequent depredation due to odor from decomposing yolk and (2) bacterial contamination. When this partially depredated nest is relocated, the remaining intact eggs should not be combined with other nests. The remaining intact eggs, regardless of the number of eggs, should be buried with six inches of moist sand above them.

### Sand Doming

During incubation, it is possible for sand to harden over the nest after a heavy rain and create a hard encrusted layer that may prevent hatchlings from emerging out of the nest. To deal with this phenomenon, if the nest is older than 40 days, you can loosen the surface sand down to about 6 inches. Be very careful. You may have live hatchlings. If the nest is less than 40 days you can actually loosen the sand all the way down to the eggs. If you inspect a couple of nests on your beach and don't find this crust, you probably do not have this problem and should not continue to check nests for doming. If you encounter doming on your beach, please contact SCDNR so we can make sure other nearby projects with similar weather patterns can be notified. Incubating nests should not be dug into for any other reason and only in the instances of heavy rain.

### Sand Accumulation over a Screen

Over the course of incubation, sand may accumulate on top of the screen or cage due to wind. This may prevent hatchlings from successfully emerging from the nest. If this accumulation occurs, lift up the screen/cage entirely and replace over the nest so that the screen remains on the surface. This is particularly important with plastic screens. Sand that accumulates over an unscreened nest should not be disturbed.

### **Tidal Inundation**

Nests in danger of being completely eroded away by high tides can be moved to safer areas anytime during incubation, with prior permission. Please contact SCDNR to discuss this before you move the nest.

### **HATCHLING AND ADULT DISORIENTATION**

Although marine turtles do nest on beaches with artificial lights, there is much evidence suggesting that they prefer darker beaches. When marine turtles choose to nest on lighted beaches, their hatchlings are at great risk. In South Carolina, artificial lighting is a growing human threat to nesting females and emergent hatchlings trying to reach the ocean.

Both nesting adults and hatchlings exposed to artificial lighting can be led in the wrong direction (misoriented) or meander and circle (disoriented). It is extremely important that marine turtle permit holders who conduct nesting surveys look for and document signs of disorientation. Please have copies of the disorientation report (found under forms on the volunteer resources page) with you at all times after July 15.

If a nest is disoriented, the following actions should occur:

1. Call your project leader and local code enforcement officer as soon as it occurs. Do not wait until the next day. It is very important that you inform your project leader of all disorientation events as soon as possible because we may be able to immediately resolve a lighting problem and thus avoid subsequent problems (additional disoriented hatchlings from the same or nearby nests).
2. Within 24 hours of the disorientation, report the event under the “loss log” on seaturtle.org under the nest that was affected. It should include the number of hatchlings disoriented and photographs documenting mortality, if possible. Photos should show the light source, not just close ups of the dead animals.

Some indirect tracks from adult turtles may not be due to artificial lighting. Adult females in search of a nesting site may wander on the beach for a period of time looking for a suitable nesting site. Leatherback turtles are known to make orientation circles on their way back to the ocean after nesting. A diagram of the crawl should be included with adult disorientation reports to help assess the actions of the turtle. Wind and rain may obscure tracks, making it difficult to document hatchling disorientation. Still, every effort should be made to count the number of hatchlings disoriented. Counting the tracks farther from the nest, in the area where the tracks spread out, is generally a little easier than trying to count the tracks right next to the egg cavity.

Identifying the light source is also important. If the disorientation was documented during a morning survey, a subsequent nighttime lighting survey would be useful in identifying the light source. The address of the property, and the number, variety and location of lights are important to the local code enforcement persons and/or SCDNR. Several counties and municipalities have lighting ordinances. A list of local ordinances and contact numbers can be found in Appendix B on the volunteer resources page. In cases where a local ordinance is in

place, the local code enforcement person is generally responsible for ensuring compliance with the ordinance.

### **Recover Disoriented Hatchlings**

All disoriented hatchlings found during darkness are to be released immediately. Artificial lights should not be utilized when collecting disoriented hatchlings. When choosing a release location, select a location that is as close to the original nest site as possible. It is also important to evaluate the lighting conditions at the potential release location. Any release location should be a relatively dark beach without light sources directly visible from the beach. Hatchlings should be able to crawl to the water unimpeded by humans, including awareness of human presence and lights. This applies to any members of the public observing, as well as all permitted personnel involved. If there is a large group of people present, please refer to Section 7 of SCDNR guidelines for crowd management. A quick check of the release area with a small flashlight fitted with a red or infrared filter a short time after release will insure that all hatchlings have reached the water.

### **HATCHING SUCCESS EVALUATIONS - NEST INVENTORIES**

Because marine turtle eggs are subjected to a variety of incubation environments, including many that are affected by human activities, it is very important each nesting season, and on each managed nesting beach, to have some idea of how many eggs actually produced hatchlings. This activity is called a nest inventory, and involves the excavation of a nest and a determination of the fate of each egg.

### **High Nest Density Sampling Design**

On higher density nesting beaches (greater than 120 nests per year), nest inventories do not have to be conducted on every nest, but a minimum of 25% is required. Useful information is obtained by conducting an inventory on a sample of nests. However, the sampling design must best represent the entire nesting season and beach. The most effective way to do this is to inventory every other nest, or every fourth nest, etc. For this sampling technique to succeed, a sampling design based on the number of nests expected needs to be in place before the nesting season begins, and this design must be followed throughout the nesting season. If needed, SCDNR marine turtle conservation program staff is available to help develop an effective sampling design. Beaches with under 120 nests per season should inventory all nests.

### **Signs of Emergence**

Emergence occurs at night just like nesting. The documented date that the nest is laid is the morning that it is found. Similarly, the date that emergence occurs is the morning that signs of emergence are first seen. The minimal waiting period is based on giving the hatchlings three additional nights to emerge after the first night. Therefore, the hatchlings have four full nights in which to emerge without interference. The chart below will provide guidance in meeting the minimal waiting period.

Signs of emergence include hatchling tracks or a large nest “crater.” A small depression should not be confused with a “crater.” A small depression over the nest cavity will occur when the

hatchling leaves the egg. A large “crater” will occur when hatchlings emerge out of the nest. A small depression is less than two inches in depth and looks as if a small mixing bowl was pressed down in the sand. A large crater looks like the egg chamber has caved in and it has distinct vertical edges rather than a sloped depression. A small depression does not indicate emergence.

### Minimum Waiting Period for Inventories

Nest inventories may only be conducted either 75 days after the nest was deposited or three days after the first morning that signs of emergence were seen, whichever occurs first (please refer to chart below). Some nests will have longer incubation duration if they have been subjected to cooler temperatures (e.g., tidal inundation, rainfall, shading, nests laid in August). In these cases, nest inventories should be conducted either 80 days after the nest was deposited or three days after the first morning that signs of emergence were seen. These are minimum waiting periods. If you encounter live hatchlings before reaching any eggs or eggshells quickly cover the nest cavity with moist sand and return the site to its original condition. Wait at least three additional days before entering that nest again.

Morning that emergence signs are first seen	SU	M	T	W	TH	F	S
Day that inventory is conducted	W	TH	F	S	SU	M	T

Digging into a nest before all the hatchlings have emerged is not allowed because it adversely affects their ability to survive. Hatchlings need a period of time after hatching to absorb their external yolk sac. If hatchlings are disturbed during this process, they may not have the energy needed to swim offshore increasing their susceptibility to marine predators. It is vital to allow all hatchlings to emerge naturally. Conducting a nest inventory early also skews the data. Since the nest has been disturbed, the data is not valid.

### Conducting a Nest Inventory

When it is time to evaluate a nest, use the marking stakes to find the egg chamber. Many times, a clutch may not produce hatchlings and the location of the clutch will not be indicated by the conspicuous signs of hatchling emergence. Moreover, some hatchling emergence evidence near the nest site may be from a nest other than the one that was marked for inventory. To accurately determine overall hatching success, it is very important that the clutches from all marked nests be found and inventoried. All undetected (wild) nests that are found at emergence should also be inventoried. A nest from which hatchlings did not emerge will be more difficult to locate again, but an inability to find these nests, and their exclusion from the sample representing one’s beach, will result in overestimating hatching success for the beach. Please make the greatest effort possible to locate all nest cavities after waiting the appropriate length of time.

To conduct a nest success inventory, dig down into the nest chamber with your hands until you reach eggs or eggshells. Do not use shovels or other tools. Disposable gloves should be worn at

all times. If you encounter live hatchlings before reaching any eggs or eggshells, quickly cover the nest cavity with moist sand and return the site to its original condition. Wait at least 3 days before excavating again.

Carefully remove the contents of the nest and place them in a pile on the sand. Separate the contents into the following FOUR categories: hatched eggs (=eggshells > 50%), unhatched eggs, live hatchlings and dead hatchlings. Count each eggshell that is more than 50% complete as one hatched egg and disregard the smaller pieces. Be sure that the individual eggshells are completely separated. Dead pipped eggs (turtle has opened the eggshell but has not left the egg) are considered unhatched eggs. An egg is not considered hatched until the hatchling actually leaves its egg. Each item found in the nest should fit into exactly one category. (Do not include live or dead hatchlings that are found on the surface of the beach as they are already emerged from the nest).

If you find live hatchlings in pipped eggs, hatchlings with yolk sacs or any viable looking eggs, do the following:

- a. Rebury the contents (dead hatchlings, unhatched eggs followed by egg shells) of the hatched nest at the bottom of the egg chamber.
- b. Add a layer of clean moist sand.
- c. Place the viable eggs and hatchlings on this layer of sand and then add additional clean, moist sand over them.
- d. Cover the area with dry sand and keep the nest location marked and screened if necessary. These turtles may never emerge due to genetic or physiological reasons.
- e. Wait five additional days to inventory the nest.

When a nest marked for inventory is completely depredated or destroyed (all eggs lost), count the egg shells, if possible, and record this data (no further inventory is necessary). This nest is a very important part of your sample to accurately determine overall nest success; do not select another nest as a sample replacement for this lost nest. When a nest marked for inventory is partially depredated, remove the depredated eggs and relocate the remaining eggs to a new nest site. Record the nest as partially depredated along with the number of eggs that were relocated and depredated.

After completing the nest inventory, the nest contents should be reburied within the original nest cavity, unless a hatchery is being used. Research has shown that the leftover nest contents contribute to the growth of dune plants.

### **Hatchling Recovery during Inventory**

Hatchling recovery does not authorize permit holders to conduct public hatchling releases or inventory a nest early during incubation. Hatchlings found at the bottom of nests during daylight excavation shall be released immediately on the beach at a distance from the waterline that is roughly equivalent to the original nest site and allowed to crawl to the water on their own. If there is a large group of people present, please refer to Section 7 of SCDNR guidelines for crowd management. A study in Florida suggests a distance of 40 feet from the surf zone for

loggerhead turtles on Florida's east coast. Someone should monitor the hatchlings to ensure gulls or ghost crabs do not take them. Under natural conditions (where kind humans do not inventory nests), these hatchlings would not have survived. They are not as fit and may even have genetic defects that prevented them from leaving the nest. These weak hatchlings may need assistance in reaching the water (if deformities exist). In such cases, they may be moved closer to the water's edge or placed in the shallows and allowed to swim off on their own. Individuals conducting the hatchling release should conduct a brief search of the surf zone and shallow water adjacent to the beach for 10-15 minutes to ensure that all hatchlings have swam away. Hatchlings collected from inventoried nests should never be held in a bucket of water.

### MARINE TURTLE NESTING SUCCESS

There are several methods used to measure the success of turtle nests. First is the percentage of hatchlings that hatch out of the shell out of the total eggs deposited (hatch success); second is the percentage of hatchlings that emerge from the nest out of the total eggs deposited (emergence success); third is the percentage of nests that produce hatchlings (10% emergence success or greater) out of the total nests laid (nest success); and fourth is the percentage of adult emergences (crawls) that result in a nest (beach success).

<b>% Hatch Success</b>	=	$\frac{(\# \text{ shells } \geq 50\%)}{(\# \text{ eggs laid})} \times 100$
<b>% Emergence Success</b>	=	$\frac{(\# \text{ shells } > 50\% - (\text{live} + \text{dead hatchlings in nest}))}{(\# \text{ eggs laid})} \times 100$
<b>% Nest Success</b>	=	$\frac{(\# \text{ nests hatched } \geq 10\% \text{ emergence success})}{(\# \text{ nests laid})} \times 100$
<b>% Beach Success</b>	=	$\frac{(\# \text{ nests laid})}{(\# \text{ crawls})} \times 100$

### REPORTING REQUIREMENTS – DUE NOVEMBER 30

The principal permit holder is required to submit by November 30<sup>th</sup> the following information listed below as a condition of being a permit holder. A quick reference to reporting guidelines can be found in Appendix A on the volunteer resources page.

1. Complete nesting data online (preferably during the season)
2. Project summary report online
3. Annual report (Appendix E on the volunteer resources page)